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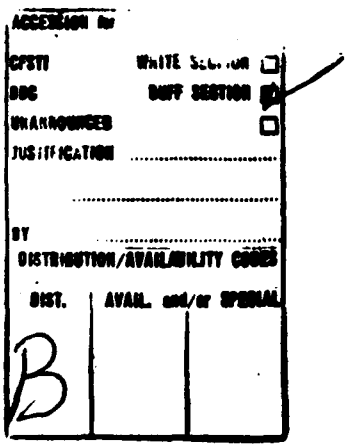
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NAVY EXPERIMENTAL DIVING UNIT
WASHINGTON NAVY YARD
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NEDU-

EVALUATION [redacted]-8-56

MSA UNIVERSAL DIVING MASK FOR SCUBA.

~~PROJECT~~ NS185-005 ~~SUBTASK 4 TEST~~ 29

W.C. HOLLINGSWORTH

30 DECEMBER 1955

CONDUCTED
AND
PREPARED

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BM1 USN

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APPROVED

M. des GRANGES
CDR, USN
OFFICER IN CHARGE

ABSTRACT

This evaluation was made to check characteristics of a prototype MSA scuba mask. The mask was tested objectively by breathing machine depth runs with respiratory pressure instrumentation, and subjectively by swimming runs with open and closed circuit scuba. Breathing machine test results are summarized as graphs of peak respiratory pressures against depth.

Subjective test results are summarized narratively. The results are discussed constructively, and lead to the following conclusions:

(1) The mask is comfortable

(2) The mask will seal well

(3) The mouthpiece is retrievable

(4) The mouthpiece does not interfere with speech

(5) Squeeze is not a problem

(6) All valves work fairly well

(7) Visibility is poor

(8) The mask is not preferred over masks of similar design

The report also draws conclusions on suitability for specific naval service and on advantages and disadvantages of the MSA mask compared with the Universal and Natascope mask.

SUMMARY

PROBLEM

(1) Is the MSA mask suitable for open, closed and semi-closed circuit scuba diving?

(2) Are there advantages and disadvantages of the MSA mask in comparison with the Bureau of Ships Contractual mask and the Natascope mask?

FINDINGS

(1) The MSA mask was not suitable for all scuba units, The MSA mask was comfortable but had poor vision.

(2) Compared with the Universal and Natascope mask, it was found that the MSA mask was not preferred over the Universal but was preferred over the Natascope mask.

RECOMMENDATION

It is recommended that additional development work and tests be made.

FOREWORD

This project was originally established for the purpose of evaluating the prototype experimental model of the Mine Safety Appliances (MSA) Universal Diving mask for scuba. This mask is being developed to provide a mask which can be used by Underwater Demolition Teams and Explosive Ordnance Disposal Units with open circuit, closed circuit and semi-closed circuit scuba diving.

CONTENTS

1. OBJECT

1.1 Objectives

This evaluation has two objectives:

(1) To determine the general suitability of the MSA mask for use with open circuit, closed circuit and semi-closed circuit scuba.

(2) To determine the specific advantages and disadvantages of the MSA mask in comparison with the Bureau of Ships Contractual mask and the Natascope mask.

1.2 Scope

This evaluation includes adaptability trials with various types of scuba, and subjective tests with one open circuit (Aqua-Lung type) and one closed circuit (LARU type) scuba.

2. DESCRIPTION

2.1 General

The prototype model MSA mask is made of black rubber with mouthpiece, bug eyes, a metal valve housing and five head straps. It is designed for open circuit, closed circuit and semi-closed circuit scuba.

2.2 Components

2.2.1 The mask proper is made of black molded rubber with a reversed flange for forming a water seal. (Reference: Figure P-2).

2.2.2 The eye ports are of the "bug-eye" type. They are made of plactic and are secured separately to the mask with metal retainer rings. (Reference Figure P-1)

2.2.3 The mask is held in position by five adjustable head straps. There is one strap leading from the center of the forehead and one from each temple. The other two straps are secured to the mask near the neck All the straps are secured to the mask by buckles. (Reference: Figure P-2.)

2.2.4 The water dump and surface breather valve is located in the lower right side of the mask near the mouth. It is a poppet valve that is operated manually by a toggle. (Reference: Figure P-5)

2.2.5 The valve housing is secured to the mask by a metal retainer ring The cut-off valve is a toggle poppet valve and is used to isolate the breathing bag from the mask. (Reference: Figure P-3)

2.2.6 The mouthpiece is secured to the valve housing by a wire clamp and rubber band. It is made of soft flexible corrugated rubber. The mouthpiece has a flange to fit under the lips and bits for holding with the teeth (Reference: Figure P-4).

3. PROCEDURE

3.1 Breathing machine test

3.1.1 The breathing machine was set at 2 liters a breath and 20 breaths a minute. The 1 psi strain gage was rigged in the recompression chamber. The analyzer was calibrated and the attenuation set to give one line deflection for one centimeter of water pressure. On the recording tape the following information was noted: the name of the equipment; the date of the calibration; the attenuation; and the direction of deflection for inhalation.

3.1.2 The mouthpiece was connected to the throat of the breathing machine. The pressure tap on the mouthpiece connector was joined to the signal side of the strain gage, and reference side was open to the chamber.

3.1.3 A continuous breathing resistance record was made from the surface to 132 feet. The tape was marked every ten feet and each atmospheric increment. The balance was checked at 132 feet and a continuous record was obtained back to the surface, with the tape being marked in the same way.

3.1.4 A check valve was installed in the mask tubes to cause the breathing machine to inhale from the right of the mask and to exhale to the left, and the sequence outlined in 3.1.3 was repeated.

3.1.5 After all the breathing machine runs were made, the data from the tape was put in graphical form by the draftsman.

3.2 Adaptability test

3.2.1 This test was made to check the adaptability of the mask to various scuba including:

(1) 1946 LARU

(2) MSA Oxygen Unit (Bureau of Ships Model)

(3) Pirelli Oxygen Unit

(4) Bureau of Ships N_2O_2 Mark I (Blair Unit)

(5) Bureau of Ships $N2O_2$ Mark III (LES Unit)

(6) Flatus Unit

(7) Div-Air Regulator

All of the adaptability tests were made in air with the subject wearing the MSA mask and Div-Air tubes. The subject wore each scuba unit in succession, and checked for curves, kinks, slack, and tension.

3.3 Open circuit swimming test with mouthpiece

3.3.1 Four subjects who are experienced with open circuit scuba, performed the following tests while using a single bottle with a Div-Air regulator with check valves in the breathing tubes:

3.3.2 Each subject swam the pool eight laps and completed each lap in approximately 2-1/2 minutes, a swim rate of about 0.8 knots. At the end of each run the subject performed barrel rolls. He then practiced flooding and clearing the mask, and ejecting and retrieving the mouthpiece. Then the subject with the aid of another diver performed an intelligibility test. These test being completed, the subjects were then asked the following questions:

(1) How is the comfort of the mask?

(2) How is the retrievability of the mouthpiece?

(3) How are the squeeze and pressurization characteristics of the mask?

(4) How well does the breathing tube cut-off valve work?

(5) How readily can seepage and flooding be cleared?

(6) How are the head harness and the mask seal?

(7) How do you like the mask?

(8) Do you have any other comments?

3.4 Open circuit swimming test without mouthpiece

The same procedure was used as in Section 3.3, omitting the questions on retrievability of the mouthpiece.

3.5 Closed-circuit test

Using a 1952 Lambertsen Amphibious Respiratory Unit, the same procedure was used as in 3.3, omitting questions on flooding and retrievability of mouthpiece.

4. RESULTS

4.1 Breathing machine test results

4.1.1 Figure G-2 shows the mask resistance from 0 to 132 feet without check valve in breathing tubes.

4.1.2 Figure G-1 shows the mask resistance from 0 to 132 feet with check valve.

4.2 Adaptability test results

The adaptability of the MSA mask to the NARU, MSA Oxygen Unit, Blair N_2O_2 Mark I, LES Unit, Flatus and Div Air was favorable for all. The adaptability of the MSA mask to the Pirelli Oxygen Unit was not favorable because the Pirelli Oxygen Unit has a pendulum breathing system. With a modified breathing system the tubes would form an S-curve from the MSA mask to a Y-connection at the front of the breathing bag.

4.3 Swimming test results open circuit with mouthpiece

4.3.1 The four subjects made the following remarks in answer to the questions listed in 3.3.1:

(1) All subjects reported the mask was fairly comfortable.

(2) All subjects reported the retrievability of the mouthpiece was good.

(3) All subjects reported that the pressurization characteristics were good. By exhaling through the nose everyone could maintain proper pressure.

(4) Three subjects reported the breathing tube cut-off valve worked well. One subject reported the cut-off valve worked well but was sometimes hard to operate because of wet hands and the shape of the toggle.

(5) All subjects reported that seepage and flooding could be cleared easily.

(6) All subjects reported the mask seal was good, but the head straps were too short.

(7) All subjects reported they liked the mask but would prefer another mask with which they were familiar.

(8) All subjects reported the mouthpiece was too soft and vision was considerably reduced in comparison to other mask with which they were familiar.

4.3.2 All subjects reported fair intelligibility using single syllable words.

4.4 Swimming test results open circuit without mouthpiece

4.4.1 The four subjects made the following remarks in answer to the questions listed in 3.3.1, omitting the question on retrievability of the mouthpiece.

(1) All subjects reported the mask was fairly comfortable.

(2) All subjects reported that the pressurization characteristics were good. By exhaling through the nose everyone could maintain proper pressure.

(3) Three subjects reported the breathing tube cut-off valve worked well. One subject reported cut-off valve worked well, but was sometimes hard to operate because of the shape of toggle and wet hands.

(4) All subjects reported that seepage and flooding could be cleared easily but was faster and easier with the mouthpiece.

(5) All subjects reported the mask seal was good, but the head straps were too short.

(6) All subjects reported they liked the mask but would prefer another mask with which they were familiar.

(7) All subjects reported the vision was considerably reduced in comparison to the other masks with which they were familiar.

4.4.2 All subjects reported fair intelligibility using single syllable words.

4.5 Swimming test results closed circuit with mouthpiece

4.5.1 The four subjects made the following remarks in answer to the questions listed in 3.3.1, omitting the question on flooding the mask.

(1) All subjects reported the mask was fairly comfortable.

(2) All subjects reported the pressurization characteristics were good. By exhaling through the nose everyone could maintain proper pressure.

(3) Three subjects reported the breathing tube cut-off valve worked well. One subject reported that the cut-off valve worked well but was sometimes hard to operate with wet hands, because of the shape of the toggle.

(4) No questions were asked on seepage and flooding of the mask.

(5) All subjects reported that the retrievability of the mouthpiece was good.

(6) All subjects reported the mask seal was good, but the head harness straps were too short.

(7) All subjects reported they liked the mask but would prefer another mask with which they were familiar.

(8) All subjects reported the mouthpiece was too soft and vision was considerably reduced in comparison to the other mask with which they were familiar.

4.5.2 All subjects reported fair intelligibility using single syllable words.

5. DISCUSSION

5.1 Comfort

The mask was comfortable to all the subjects. The rubber is flexible and the inverted lip forms a gas seal very easily. However the straps were short and it is believed that any diver with a large head would find the mask tight and uncomfortable.

5.2 Retrievability of the mouthpiece

Ejecting and retrieving the mouthpiece was fairly easy, due to its construction of soft corrugated rubber. However the rubber, being too soft, gave the subjects a tendency to grip the mouthpiece too hard with their lips, thereby closing off the gas supply.

5.3 Intelligibility

As long as speech was restricted to simple phrases and one syllable words, intelligibility was reasonably good. For complex sentences and long words, intelligibility dropped off rapidly.

5.4 Squeeze and pressurization

In the MSA mask neither squeeze nor pressurization is a problem for the experienced diver. On the first sign of a squeeze, the diver automatically exhales through his nose, pressurizing the mask independently of his breathing system.

5.5 Valves

5.5.1 All the valves worked very well during the swim test except for one subject having a little trouble because of wet hands and not being accustomed to a toggle poppet valve. However, after the swimming test were over and the valves disassembled, it was found that the spring for the cut-off valve had started to rust. If the cut-off valve spring could be made of a non-corrosive metal this would be no problem.

5.6 Visibility

5.6.1 In comparison with other masks of similar design, the MSA mask seemed to have a considerably reduced visual field.

6. CONCLUSIONS

6.1 Conclusions

6.1.1 The following conclusions apply to the mask itself:

(1) The mask is comfortable (Section 5.1).

(2) The mask seals well on all faces (Section 5.1).

(3) The mouthpiece is retrievable (Section 5.2).

(4) The mouthpiece is too soft (Section 5.2).

(5) Squeeze is not a problem (Section 5.4).

(6) Valves work well but check valve spring may need modifying (Section 5.5).

6.1.2 The MSA mask is not suitable for all scuba units (Section 4.2).

6.1.3 The following is a compairson of advantages and disadvantages of the MSA mask with Universal and Natascope masks.

	MSA Mask	Universal Mask	Natascope Mask
Comfort	B	A	C
Mouthpiece Preferred	C	A	B
Intelligibility	A	B	B
Mask Seal	A	A	B
Visibility	C	A	B
Mask Preferred	B	A	C

6.2 Recommendations

In view of the conclusions under 6.1.2 and 6.1.3 it is recommended that additional development work and tests be made.

7. FIGURES

7.1 Photographs

7.1.1 Figure P-1 is a front view of the mask on a subject.

7.1.2 Figure P-2 is a back view of the mask laid out.

7.1.3 Figure P-3 is a view of cut-off valve, mouthpiece and valve housing.

7.1.4 Figure P-4 is a view of cut-off valve, mouthpiece and valve housing disassembled. The following numbers label the parts indicated:

(1) Mouthpiece

(2) Rubber band

(3) Clamp for sucuring valve to the mask

(4) Valve housing

(5) Valve seat

(6) Valve spring

(7) Valve stem guide

(8) Valve stem and toggle

(9) Retainer ring

7.1.5 Figure P-5 is a side view of mask on a subject showing water drain valve.

7.2 Graphs

7.2.1 Graphs G-1 shows breathing resistance from the surface to 132 feet without check valves in breathing tubes.

7.2.2 Graph G-2 shows breathing resistance from the surface to 132 feet with check valve in breathing tube.

UNIVERSAL DIVING MASK

FOR SCUBA

1 2 3 4 5 6 7 8 9

PROJECT NS 18[illegible] 005

SUBTASK 4 TEST 29

FIGURE 4

PROJECT NS 185-005

SUBTASK 4 TEST 29

FIGURE 2

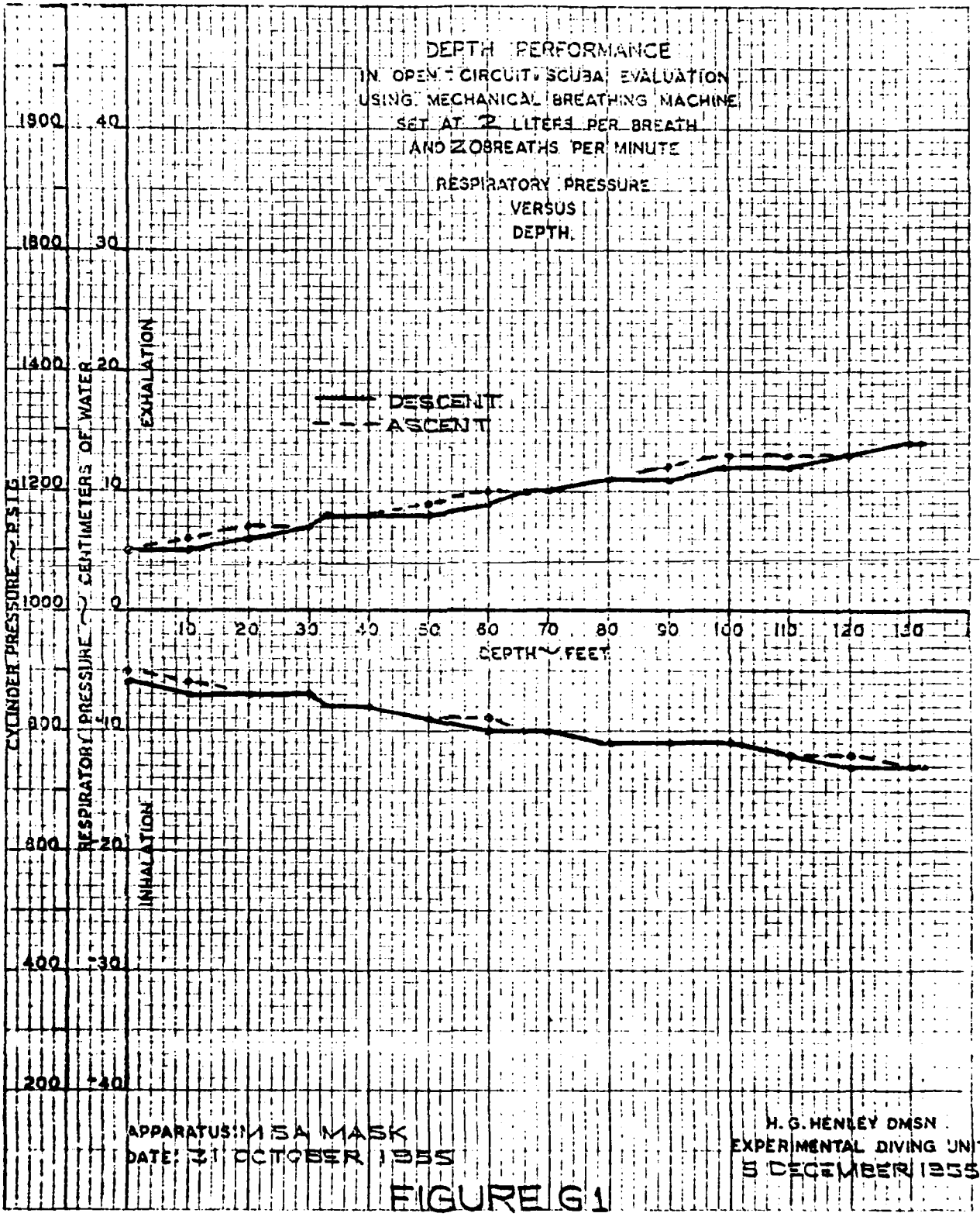
UNIVERSAL DIVING MASK

FOR SCUBA

PROJECT NS 185-005

SUBTASK 4 TEST 29

FIGURE 3


DEPTH PERFORMANCE
IN OPEN CIRCUIT SCUBA EVALUATION
USING MECHANICAL BREATHING MACHINE
SET AT 2 LITERS PER BREATH
AND 20 BREATHS PER MINUTE
RESPIRATORY PRESSURE
VERSUS
DEPTH.
DESCENT
ASCENT
EXHALATION
INHALATION
CYLINDER PRESSURE ~ P.S.I.G.
RESPIRATORY PRESSURE ~ CENTIMETERS OF WATER
DEPTH ~ FEET
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100
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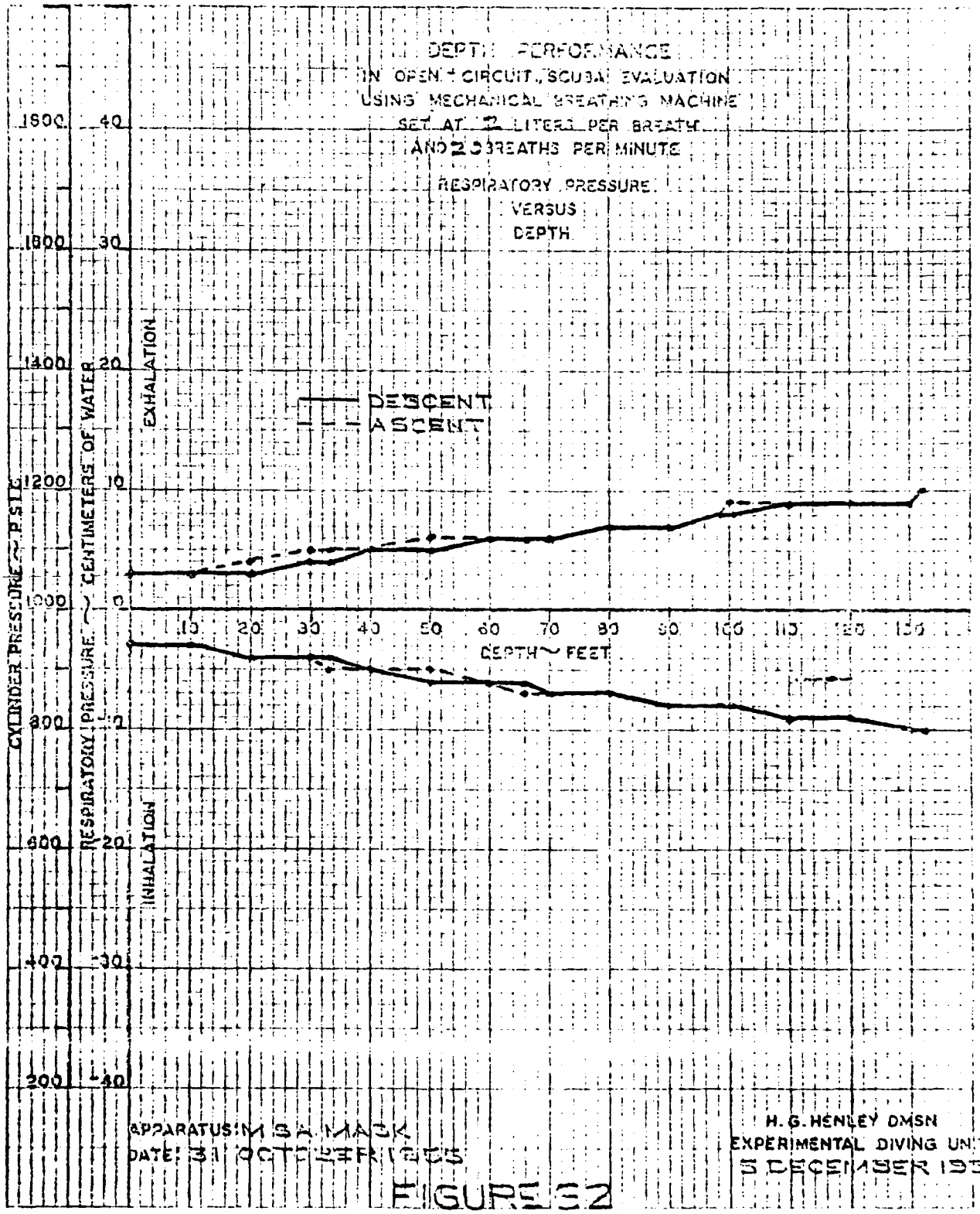
APPARATUS: MSA MASK
DATE: 21 OCTOBER 1955
H. G. HENLEY DMSN
EXPERIMENTAL DIVING UNIT
5 DECEMBER 1955

FIGURE 61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APPARATUS: M.S.A. MACK
DATE: 31 OCTOBER 1955
H. G. HENLEY DMSN
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5 DECEMBER 1955

FIGURE 32

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13. ABSTRACT

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